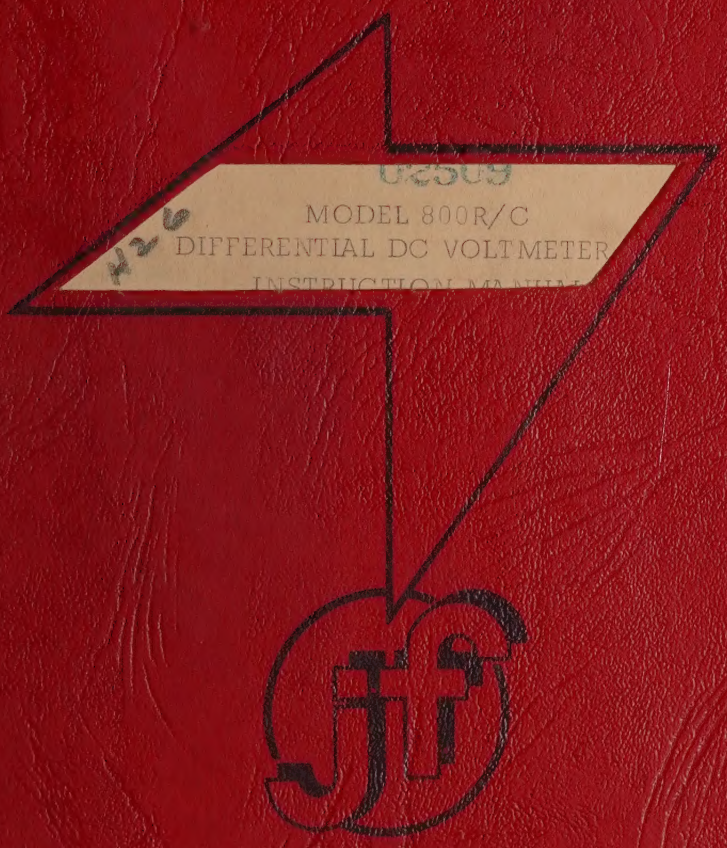
INSTRUCTION MANUAL



john fluke MANUFACTURING CO., INC.
P. O. BOX 7161
SEATTLE 33, WASHINGTON

2509

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MODEL 800R/C
DIFFERENTIAL DC VOLTMETER
INSTRUCTION MANUAL

#26

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INSTRUCTION
MANUAL
FOR

MODEL 800R/C

DIFFERENTIAL VOLTMETER

SERIAL NUMBER 125 AND ABOVE

MODEL 800R/C DIFFERENTIAL VOLTMETER

ERRATA SHEET

The Model 800R/C Differential Voltmeter is identical with a standard Model 800R except 117 volt a-c input and instrument plus and minus terminals are provided on the rear of the unit terminating in an MS-3102A-18-11S connector.

Throughout this instruction manual all references to the Model 800 or 800R should read Model 800R/C.

On page 5 of the List of Replaceable Parts delete:

Cable power, 2 conductor #18	X27E
Bushing, line cord strain relief	X212

Add:

Connector, MS-3102A-18-11S

Connector, MS-3106A-18-11P

Cable clamp, AN-3057-10

+
−
D. C. VOLTS
JOHN FLUKE MFG. CO., INC.
SEATTLE, WASH.
MTR ZERO
OP CAL
ADJ CAL
RANGE
1V
X 100
3
X 10
4
X 1
9
X .1
9
X .01
8
DIFFERENTIAL VOLTMETER
MODEL 800

MODEL 800 DC DIFFERENTIAL VOLTMETER

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MODEL 800 DIFFERENTIAL DC VOLTMETER

CONVENTIONAL VTVM SPECIFICATIONS

Voltage Ranges:	0 to ±500, *0 to ±10, *0 to ±1 volts DC
Input Resistance:	10 megohms
Scales:	500-0-500, 1-0-1 volts DC
Accuracy:	±4% of full scale

*These ranges obtained by setting RANGE knob to either 10V or 1V with 5 voltage knobs set to 0.

DIFFERENTIAL VTVM SPECIFICATIONS

Voltage Range:	0 to 500 volts DC
Input Resistance:	Infinite at null. 2000 megohms per volt of input voltage for 0.005 volt of unbalance as indicated by meter.
Scales:	1-0-1 and 10-0-10 volts DC
Accuracy:	±.05% of actual voltage from 10 volts to 500 volts ±.1% of actual voltage or 5MV, whichever is greater, below 10 volts.
Resolution:	0.01 volt read directly on calibrated controls. Greater resolution available by reading meter.
Stability of Reference Supply:	0.01% for 20% change in line voltage (105V to 130V) 0.01% per hour after warmup (adjustable by front panel CAL ADJ. control)
Stability of Meter Zero:	5% of full scale for 20% change in line voltage (105V to 130V) 2% per hour after warmup (adjustable by front panel MTR. ZERO control)
Calibration:	500 volt reference supply calibrated against built in standard cell
Input Power:	100-130 volts, 60 cycles, 52 watts
Dimensions:	Cabinet Model: 9-3/4"W x 13"H x 14"D Rack Mounting Model: 19"W x 8-3/4"H x 16-3/4"D
Finish & Weight:	Smooth grey panel. Grey baked wrinkle case. Cabinet Model 21 lbs.; Rack Mounting Model 23 lbs.
Price:	$385 Cabinet Model; $405 Rack Mounting Model

JOHN FLUKE MFG. CO., INC., P. O. BOX 7161, SEATTLE 33, WASH.

MODEL 800

DIFFERENTIAL VOLTMETER

INSPECTION

This instrument has been thoroughly checked and tested before being shipped from the factory. Upon receipt of the instrument, inspect carefully for any damage which may have been incurred in transit. Reference should be made to the Warranty section of this instruction manual for the procedure to be followed if any shipping damage has occurred.

INITIAL OPERATION

1. Connect the instrument to 117 volt, 60 cycle single phase source. Then turn on the instrument by turning the RANGE switch to the CAL position. Meter should now light up. Allow instrument to warm up for approximately 5 minutes.

2. After the warm up period, the instrument should be calibrated. Calibration of the instrument is accomplished with the RANGE switch in the CAL position, by turning the OP CAL switch to the CAL position with the left hand while adjusting the ADJ CAL control with the right hand for absolutely no deflection of the meter needle. Maximum accuracy is obtained with the Model 800 when this operation is carefully performed. Check for perfect null by turning and releasing the OP CAL switch and checking for no movement of the meter needle. When this operation is carefully performed the reference supply will be set to 500 volts within .01%.

3. Adjust MTR. ZERO knob. To do this, set RANGE switch to 500 position and bring meter needle to zero by adjustment of the MTR. ZERO knob (with nothing connected to the input posts.) Turn RANGE switch to 10V and 1V positions - meter should remain on zero.

4. During the first 20 minutes of operation it is advisable to check the calibration and meter zero once or twice, since maximum stability of both the 500 volt reference supply and the cathode follower VTVM is attained after the instrument has reached normal operating temperature.

TO MEASURE DC VOLTAGE

1. Determine the approximate value of the unknown voltage. Turn the RANGE switch to the 500V position and zero the meter by adjusting the MTR. ZERO control. Connect the unknown voltage to be measured to the plus and minus terminals with the shorting link connected between minus and G posts. With the RANGE switch in the 500V position, the Model 800 functions as a conventional zero center, vacuum tube voltmeter with ten megohms input resistance and a 500-0-500 volt range. The voltage under measurement may be read to an accuracy of 4% in this position. A left hand deflection of the needle indicates that the leads to the instrument should be interchanged before attempting to make differential voltage measurements.

2. To measure DC voltages to .05%, set up the voltage indicated by the meter on the X100 and X10 controls. Then set the RANGE switch to the 10V position at which time the meter indicates the difference between the unknown voltage and the internal calibrated voltage. Next adjust the voltage knobs until the meter reads less than 1 volt of unbalance. Now turn the RANGE switch to the 1V position for greater sensitivity and again adjust the controls, particularly the X.1 and X.01 controls, until the meter reads zero. The unknown voltage may now be read directly on the five voltage dials accurate to .05% of the actual voltage (.1% or 5MV below 10 volts.)

OBSERVING EXCURSIONS OF A VOLTAGE ABOUT A NOMINAL VALUE

Set up the nominal voltage on the five voltage dials as outlined above and observe the excursions directly on the meter in either the 10V or 1V position of the RANGE switch. A right hand deflection of the needle indicates that the voltage under observation has increased above the nominal value by the amount indicated by the meter reading; a left hand deflection indicates the voltage has decreased by the amount indicated by the meter reading.

TO USE AS A CONVENTIONAL VTVM ON THE TWO NULL RANGES

In addition to the 500-0-500 volt VTVM "Search" range in the Model 800, two additional ranges are available. These are 10-0-10 and 1-0-1 volts at 10 megohms input resistance. These ranges are available by setting all five voltage knobs to zero, connecting the voltage to be measured to the input posts, and setting the RANGE dial to the desired voltage range. Accuracy in these two additional ranges is ±4%.

MEASUREMENT OF HIGH VALUE RESISTANCES

The Model 800 may be used to measure resistances between 1 megohm and 500,000 megohms very quickly and conveniently. The unknown resistance can often be measured at any voltage between .01 and 500 volts to simulate actual operating conditions. Examination of the Model 800 circuitry and application of elementary circuit theory will produce the following equation for determining values of resistances with the Model 800:

$$RX = 10^7 \left(\frac{E}{Em} - 1\right) \text{ where}$$

RX is the unknown resistance in ohms
E is the voltage setting of the five voltage knobs
Em is the meter reading on the appropriate scale; either 10-0-10 or 1-0-1 volt, as determined by the RANGE switch
10^7 is the input resistance of the VTVM in ohms

1. To measure high value resistance set the RANGE switch to either the 10V or 1V position. Zero the meter by means of the MTR. ZERO control.

2. Connect the unknown resistance between the plus and minus terminals. Leave link connected between - and G terminals. Avoid the use of long twisted leads

since the Model 800 can easily measure the leakage resistance of the insulation of such leads. It is best to use very short isolated leads. Connect the negative terminal to the grounded side of the resistance under measurement (if one side happens to be grounded) or to the common ground point if in a "floated" circuit.

3. Now adjust voltage controls to any desired value between .01 and 500 volts or to any voltage which allows convenient reading of the meter, that is, produces a reasonable easily read meter deflection - say 10% of full scale.

4. Read the meter, the voltage dials and the RANGE switch and substitute these values in the above equation and compute the value of the unknown resistance.

5. For rapid measurement of resistances up to approximately 500 megohms without use of the formula, merely set RANGE switch to the 10 volt position, adjust voltage dials for full scale meter deflection and subtract 10 from the reading of the voltage dials. This is the value of the unknown resistance in megohms.

6. For rapid measurement of resistances up to approximately 5,000 megohms without use of the formula, set RANGE switch to the 1 volt position and adjust voltage dials for full scale meter deflection. Subtract 1 from the reading of the voltage dials and multiply the difference by 10 - this is the value of the unknown resistance in megohms.

CIRCUIT DESCRIPTION

The Model 800 Precision Differential DC Voltmeter operates on the potentiometer principle wherein an unknown voltage is measured by bucking it against an adjustable known voltage and reading the difference on a sensitive null detector. When zero displacement current flows in the null detector, the unknown voltage is exactly equal to the known voltage and the impedance presented to the unknown voltage source by the known voltage source and null detector is infinite.

The circuit consists of five main elements, which are:

1. A super regulated, extremely stable 500 volt reference source.

2. Means for setting this reference source to 500 volts within ±.01%.

3. A calibrated 5 decade Kelvin-Varley precision attenuator for dividing the reference voltage down to the exact level of the unknown voltage.

4. A calibrated multi-range VTVM which is used both as a conventional VTVM for determining the approximate value of the unknown voltage and also as a calibrated null detector for measuring the difference between the unknown voltage and the known voltage derived from the 5 decade calibrated attenuator.

5. Appropriate attenuators for reducing the signal input to 1 volt maximum for the VTVM range and the first null range (10V).

Element 1 consists of an unregulated 900 volt DC supply (V1,R1,C1,and C2), a pre-regulator delivering 625 volts at 1% regulation (V2,V3,V5 and associated components), and a super-regulator delivering 500 volts at .01% regulation (V4,V6,V7,V8 and associated components). The super-regulator uses the highly stable type 5651 reference tubes, a carefully balanced differential amplifier as the equating element, and precision wire-wound resistors in the sampling circuit. The stability of this 500 volt supply is better than .01% per hour after a short warm-up period.

Element 2 consists of P1,S7, a standard cell, a precision wire-wound divider (R15, R19,R16, and P2) across the 500 volt supply from which is derived a voltage exactly equal to the EMF of the particular standard cell used when the output is exactly 500.00 volts, a 50-0-50 microamp meter M1, and RANGE switch sections S6C and E for connecting the meter between the standard cell and 1 volt sample of the 500 volt output.

To calibrate, S7 "OP-CAL" switch is turned to CAL position and P1 ADJ CAL knob is rotated until there is no deflection of the meter needle.

Element 3 is made up of S1, S2, S3, S4, S5, and associated matched precision wire-wound resistors, R20 through R68. The resistors on the A switch are factory matched to be within ±.005% of each other; those on the B switch to within ±.012%; those on the C, D, and E switches to within±.025%. If any of the resistors in this 5 dial attenuator become defective, send resistor value and serial number of the instrument to John Fluke Mfg. Co., Inc., where a record is kept of the exact values used in each instrument shipped; in this way a replacement can be obtained which will not upset the matching of the other resistors on the particular switch.

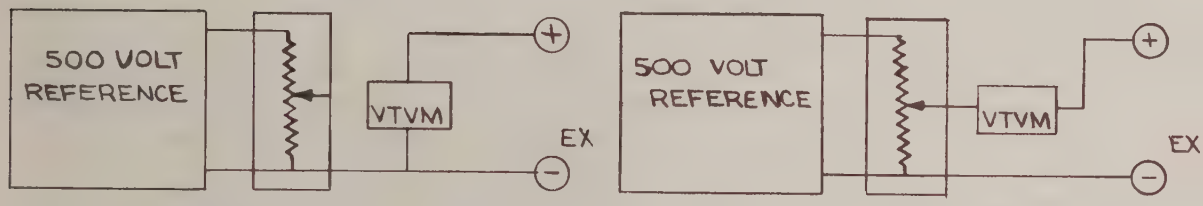
Element 4 consists of a cathode follower type VTVM, V102 and associated components R103, R104, R105, C102, P101 (meter zero control for 500V, 10V and 1V ranges), M1, and RANGE switch sections S6C and S6E for switching the meter from the CALIBRATE function to the VTVM function. This VTVM has a basic full scale sensitivity of 1 volt; that is, a 1 volt DC signal applied between pin 2 of V102 and the 0 volt bus of the voltmeter channel, with everything to the right of R105 cast loose, will cause the meter to deflect full scale right or left depending on whether the signal is positive or negative respectively (pin 2 with respect to 0 volt bus.)

Element 5 consists of the appropriate sections of the RANGE switch S6, together with associated resistors R106 through R110. RANGE switch section S6D and resistors R108 through R110 divide the unknown voltage down to 1 volt from either 500 or 10 volts, depending on the setting of the switch. RANGE switch section S6A and resistors R106 and R107 are used to maintain the resistance between input grid of VTVM (pin 2 of V102) and negative side of voltmeter channel constant at 11 megohms.

In order to use the instrument as a straight VTVM, the negative input binding post is connected directly to the negative side of the voltmeter channel via RANGE switch S6F; the positive input binding post is connected to the RANGE switch divider via switch S6D and the VTVM input grid is connected to the output of the

RANGE switch divider via switch S6A. This is illustrated in block diagram below.

In order to use the instrument in the differential mode, the entire voltmeter channel is "floated" between the output of the 5 dial attenuator and the positive input binding post. The block diagram below illustrates this.



5 Dial
Attenuator
STRAIGHT VTVM

5 Dial
Attenuator
DIFFERENTIAL VTVM

This is effected via RANGE switch section S6F while RANGE switch section S6D serves to attenuate the 10 volt out of balance signal (when operating in the 10 volt null range) to 1 volt for application directly to the cathode follower VTVM input grid (pin 2, V102). In the last position of the RANGE switch (1V) the out of balance signal is applied directly to the cathode follower input grid.

Screwdriver adjust control P102 is adjusted so that full scale meter deflection results when exactly 500 volts is applied to the input binding posts with RANGE switch set to 500V position.

This concludes the circuit description. Should trouble occur, an orderly step by step servicing procedure should locate the source. Refer to the "Trouble Shooting Hints" section of this book for assistance in isolating and repairing the fault. If trouble cannot be isolated, write us giving full details of the difficulty and include serial number. On receipt of this information we will send service data or shipping instructions.

CAUTION: IT IS RECOMMENDED THAT THE PLUG TO THE STANDARD CELL BE REMOVED WHEN TROUBLE SHOOTING TO PREVENT ACCIDENTAL SHORTING AND DAMAGING OF THE CELL.

MAINTENANCE NOTES

1. Tube replacement. All tubes used in the Model 800 are, with the possible exception of the type 5651 reference tubes, common receiving types. Only two of the 10 tubes used are at all critical - these are V6 in the 500 volt reference supply and V102 in the VTVM channel. Should replacement of these be necessary, the following procedure should be followed to insure optimum performance of the instrument. We recommend replacement of these two with factory pretested tubes.

   V6 - this tube is a high mu dual triode, type 12AX7, used as a differential amplifier. This connection insures maximum stability and minimum effects from line voltage change. Some tubes have poor balance between halves, however, causing poor regulation against line voltage. Check for this by allowing 5 minutes to tube to heat and then varying line voltage from 100 to 130 volts and checking reference supply output voltage with another 800 or 801. The 500 volts must not change by more than 50 millivolts (.01%) over this range of line voltage. If regulation exceeds this figure discard tube in favor of another.

   V102 - this tube is a medium mu dual triode used in a cathode follower type VTVM circuit. The two requirements of V102 for satisfactory performance are good balance between halves and low grid current. These can be checked by setting RANGE switch to 1V position, and all 5 voltage knobs to zero. Allow a few minutes for tube heating and then check for ability to zero meter. At zero, the meter zero knob pointer should like within $\pm 90^{\circ}$ of veritcal. If outside these limits remove tube and try another. If okay, vary line voltage from 100 to 130V and check stability of meter zero. Meter should not offset more than 5% (2 small scale divisions). If it does, discard V102 in favor of another with better balance.

   To check for excessive grid current in V102, set RANGE knob to 1 volt position, the five voltage knobs to zero and line voltage to 117 volts. Zero meter and then short the input binding posts. Meter offset must not exceed 1/4 of one small scale division - if it does, replace V102. Shorting the input posts changes the resistance in the grid circuit of the righ half of V102 from 10 megohms to 1 megohm. Assuming the small grid current to be constant (which is not strictly true) this change in grid resistance appears as a change in grid voltage which causes a small meter offset to the left. The average Amperex 12AU7 produces offset of from 1/4 to 1/2 of one small scale division. It is important that this offset be kept to a minimum in order that slight errors not result from measuring EMF's with widely varying internal resistances. This is not error due to external circuit loading since the 800 at null presents infinite resistance to the external circuit. Rather it is error due to shunting of the normal 10 megohms VTVM grid circuit resistance by the internal resistance of the voltage source under measurement.

   The John Fluke Mfg. Co., Inc. sales representative in your area maintains a stock of aged replacement tubes selected for optimum performance in these two critical spots (V6 and V102). If replacement becomes necessary, contact him and advise tube type required. This is usually simpler than selecting tubes from stocks on hand.

2. General Cleaning. The Model 800 is extremely sensitive to the slightest amount of electrical leakage from the VTVM channel, particularly the input grid of V102 (pin 2) and all its associated wiring to the negative side of the input. Leakage resistance of 40,000 megohms between this grid circuit and the negative input will cause a 10% left meter deflection in the 1 volt null range when voltage dials are set to 400 volts; lower values of leakage resistance will cause larger no signal meter deflection. An analysis of the 800 circuitry will show that it meters its own internal leakage resistance. Therefore, the instrument should be cleaned occasionally to remove dust and foreign matter, particularly from the two Plexiglass strips which insulate the VTVM chassis from the metal frame of the instrument, the positive binding post and the ceramic RANGE switch. Blow the instrument out with a low pressure air hose (be sure air is dry) and wipe strips off with a clean dry rag. If necessary wipe the Plexiglass strips with a rag saturated in Metriclene Solvent M-4 (manufactured by the John B. Moore Corp., Nutley, New Jersey). This is a high grade, non-toxic solvent for use on delicate electrical equipment. Many other solvents have very poor electrical properties and leave a residue which may be slightly conductive. Switches may be washed using a small stiff bristled brush dipped in Metriclene. After washing, the ceramic surfaces must be recoated with a 10% solution of Dow Corning 200 Fluid (100 viscosity grade) in Metriclene. This prevents moisture collecting across the ceramic surfaces.

If the instrument is stored for a considerable period of time in a hot humid atmosphere considerable leakage may be noted upon initial operation. This is evidenced by large meter offsets in the null ranges as the voltage dial settings are increased. This usually clears up as the instrument warms up and dries out, if not remove from case and wipe above mentioned surfaces with clean cloth.

If necessary to clean the binding post insulators, do not use Metriclene. Use only pure denatured alcohol and a clean cloth since the insulator material is slightly solvent in Metriclene.

TROUBLE SHOOTING HINTS

1. Excessive drift in 500 volt reference supply - this is evidenced by having to recalibrate the unit every five or ten minutes for an hour or more. Trouble is usually a defective reference tube V7 or V8, or a faulty equating tube V6. A leaky feedback capacitor C6 may cause either drift or unstable operation.

2. Excessive drift in VTVM - drift should stop after a few minutes operation. If it persists, replace V102.

3. Inability to calibrate instrument - If meter deflection cannot be reduced to zero by following step 2 under "Initial Operation" trouble is one of following:

    A. Either R17 of R18 has shifted, making it impossible to bring output of super-regulator to 500V. Replace out of tolerance unit.

B. V7 and/or V8 have aged to the point where their running voltage is too low. Replace them if this is the case. Their running voltage should lie between 85 and 87 volts. Screwdriver adjust control P3 may be adjusted to bring the front panel CAL ADJ control to the approximate center of its rotation at the point meter deflection has been reduced to zero. Also, a precision wire-wound resistor may be added where jumper X is used (forward edge of large printed circuit board) to compensate for reference tubes with low running voltages or to trim the string in the event replacement of R17 and/or R18 must be made with values other than those specified. Only do this in an emergency and never use anything but precision wire-wound resistors wound with either Evanohm, Karma, or Manganin alloys. Under no conditions attempt replacement with ordinary power resistors, Nichrome resistors, carbon or deposited carbon resistors, or metal film resistors. This statement applies to every single precision wire-wound resistor in the instrument.

C. One of the three wire-wound resistors in the standard cell sampling string has changed value. These are R15, R16, and R19. If replacement of any of these is necessary the instrument must be recalibrated. See recalibration instructions.

D. The standard cell may have shifted value very badly. It should measure between 1.0190V and 1.0196V. Use only a Model 801 or a Leeds & Northrup type K potentiometer (or other similar pot) to make this measurement. DO NOT USE A VOLTOHMMETER. If replacement of cell is necessary instrument must be recalibrated. See recalibration instructions.

E. Failure of either the rectifier filter (V1,C1,C2), the super-regulated power supply (V4,V6,V7,V8) or the pre-regulator (V2,V3,V5). Output of the rectifier filter should run approximately 900 volts at a line voltage of 117 volts. Output of the pre-regulator should run 610 to 640 volts and be regulated to better than 1% over range of 100 to 130 volts line. Output of the super-regulator must obviously be 500 volts and should have a range of adjustability of at least 5 volts either side of 500. Regulation must be .01% or better over range of 100 to 130 volt line.

4. Error in excess of specified values. This is caused either by the instrument being out of calibration or by a defective resistor in the 5 dial Kelvin-Varley voltage divider.

A. A quick check to determine whether this divider is okay consists of setting the 5 voltage dials to 400.00 and applying an EMF from an extremely stable high resolution DC power supply, such as the John Fluke Models 301C, 406, or 407. Adjust supply until a null is obtained in the 1 volt range. Then remove voltage from input and reset the 5 voltage dials to 399.9^{10}. Reconnect the 400 volts to the instru-

ment again with RANGE switch in 1V position. Meter should null within 80 millivolts (.02%). Repeat this check applying 50 volts and setting up 50.00 first on the voltage dials and then 49.9^{10}. Difference in the two readings must be less than ±25 millivolts (.05%).

Non-linearity is usually traceable to one defective wire-wound resistor on one of the five switches. Since these are matched units the drops across each resistor on a particular switch should lie within .01% of each other on X100, .025% on X10, and .05% on the other three. If replacement of any resistor is necessary wire serial number of instrument to factory where a stock of matched replacements is maintained.

B. To determine whether instrument is still in calibration, perform the calibration operation as outlined in step 2 under "Initial Operation". Then apply a KNOWN 500 volts - this voltage must be accurate to .01% or better - to the instrument and measure it. It must read between 499.90 and 500.10 volts (±.02). If outside these limits follow recalibration instructions.

NOTE: A 500 volt EMF accurate to .01% is extremely difficult to obtain. If there is any doubt in your mind as to the accuracy of your 500 volts do not use it. Instead contact our field representative in your area. Most of them have in their repair stations a John Fluke approved precision calibration set up and therefore can perform this important check to the accuracy required.

5. Error in the VTVM readings - If meter reads off in the 500V search range as well as the 10 and 1 volt NULL ranges, adjustment of P102 is probably required. This is the screw driver adjust potentiometer on the small printed circuit board. If error lies in only the 10 or 500 volt range, trouble is probably in divider string consisting of R108, R109, and R110.

NOTE: DO NOT POKE AROUND THIS DIVIDER WITH A SHARP POINTED TOOL. IF A DEPOSITED CARBON RESISTOR COATING IS SCRATCHED DEEPLY ENOUGH THE RESISTOR WILL OPEN UP.

6. Meter needle offsets to the left as voltage dial settings are increased (RANGE dial in 1V position, nothing connected to the input posts) - This indicates leakage between grid pin 2 of V102 and the minus side of instrument. See MAINTENANCE NOTES under "General Cleaning" for discussion of this.

7. Excessive error which appears only at low voltages - This is caused either by a defective wire-wound resistor on S4 or S5 (X.1 or X.01 switch) or by excessive grid current of V102. See MAINTENANCE NOTES, page 6, for discussion of grid current. See TROUBLE SHOOTING HINTS, heading 4A, for discussion of Kelvin-Varley non-linearity.

8. Meter needle rattle - Trouble may lie in the source under measurement which is not steady or in the bucking voltage developed in the 800, or in the VTVM in the 800. To check the first two possibilities apply an absolutely steady voltage and see if meter needle wobble ceases. If it does, trouble was in the source. If wobble is still present remove signal from input posts altogether. If wobble still is present trouble is in VTVM. If wobble disappears trouble is either in 500 volt reference supply or Kelvin-Varley divider.

   To track down trouble in 500V reference, use another M odel 800 or 801 and monitor the output of the 500 volt reference supply of the defective 800. If 500 volts is steady, trouble is in Kelvin-Varley. If 500volts is not stable, trouble may lie in R17, R18, R7 or any of the tubes in this supply. Also may be a leaky feedback capacitor C6. May also be caused by trouble in the 625 volt pre-regulator.

RECALIBRATION INSTRUCTIONS

If it has been positively determined that the instrument is out of calibration (see heading 4(B) , proceed as follows:

Apply a known 500 volts (accurate to .01% or better) to the instrument. Set 5 voltage dials to 499.9^{10} and turn RANGE dial to 1 volt position. Bring needle to zero by adjustment of the ADJ. CAL. control. Then withdraw instrument part way out of the case to gain access to P2, a screwdriver adjust control located at the bottom of the large printed circuit board. Now turn RANGE knob to CAL. position and rotate the CAL. switch - rock it back and forth and check for meter deflection. With a screwdriver, adjust P2 until the meter deflection has been eliminated when the CAL. switch is rocked. The instrument is now back in calibration. Push instrument back in case and recheck calibration once more. If okay apply a dab of Duco Household Cement to P2.

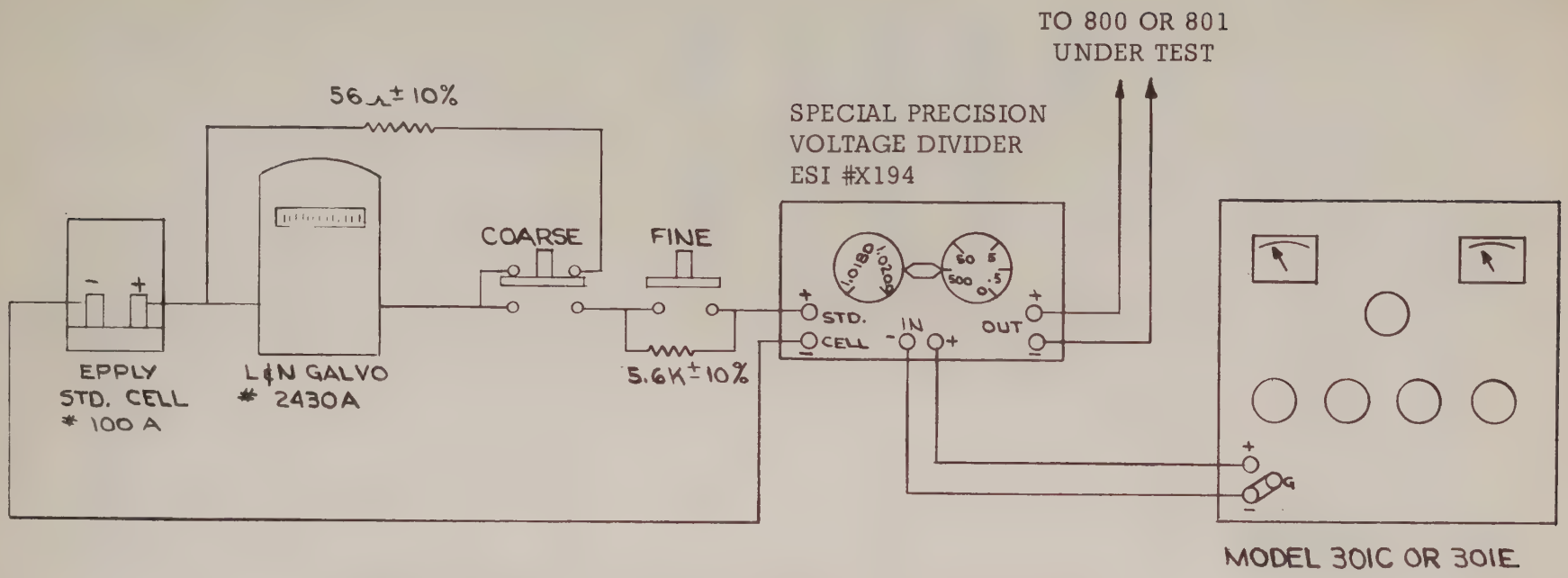
A recommended set-up for calibrating the Model 800 and Model 801 is discussed in the next two pages.

RECOMMENDED CALIBRATION SET-UP

The hook-up of equipment required for final calibration of Models 800 and 801 is shown in Fig. 1. The heart of this set-up is the precision voltage divider, ESI #194, built by Electro Measurements, Inc. in Portland, Oregon. This divider is so constructed that when the left hand knob is set to the exact EMF of the Eppley standard cell shown at the extreme left and the 301C output voltage controls are adjusted until the Leeds & Northrup galvo comes to null with both COARSE AND FINE buttons pushed, the EMF applied to the precision divider will be 500 volts within plus or minus .005%. The precision of this divider is such that the three divided down EMF's of 50, 5, and .5 volts will also be accurate to within plus or minus .005%. These figures obtain at 72°F and the accuracy will be maintained within plus or minus .01% providing room temperature does not deviate more than plus or minus 5°F from this figure.

It is necessary, of course, that the EMF of the particular standard cell being used be known to an accuracy of plus or minus .002%. This means certification by some group who has a bank of saturated standard cells. The Eppley Model 100 standard cell is encased in a special phenolic housing which is thermally insulated and lagged. We strongly recommend that it be further insulated and lagged by housing it in an aluminum box inside of a wooden box with 3 inches of glass wool between cell and aluminum box and another 3 inches between boxes. While the Eppley 100 cell is of the unsaturated type which the Bureau of Standards will certify only to .01%, it will nevertheless maintain an extremely constant EMF if treated with care and not subjected to sudden temperature changes. Many groups will read an unsaturated cell's EMF down to the fifth place so that if you use this value in setting the standard cell knob of the ESI divider and treat the cell with care you can be reasonably sure that you are within plus or minus .002% (20 parts per million) of the true EMF of the cell. Overall accuracy of the system then is plus or minus .005% plus or minus .002% or somewhere between .003% and .007%, which is quite adequate for calibrating a .05% instrument.

HOOK-UP OF TEST EQUIPMENT USED IN FINAL CALIBRATION OF MODELS 800 AND 801



COARSE & FINE SWITCHES ARE MOMENTARY PUSH BUTTON TYPE SHOWN IN NORMAL UNDEPRESSED POSITION. SINCE THESE SWITCHES ARE IN THE STANDARD CELL CIRCUIT THEY MUST HAVE FINE SILVER CONTACTS.

FIG I

MODEL 800

LIST OF REPLACEABLE PARTS

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
C1, C2	Capacitor, oil 1 mfd, 1000 v	CO20
C3,	Capacitor, paper .1 mfd, 600 v	CP5
C5	Capacitor, paper .047 mfd, 400 v	CP6
C6	Capacitor, paper .01 mfd, 1600 v	CP1
C7	Capacitor, mylar .1 mfd, 600 v	CP20
C101	Capacitor, electrolytic 8 mfd, 250 v	CE10
C102	Capacitor, paper .022 mfd, 600 v	CP18
R1	Resistor, composition 390 ohms, 10%, 1 w	GB3911
R2	Resistor, composition 470 k, 10%, 1/2 w	EB4741
R3A, thru F R4A, R4B	Resistor, composition 22 k, 10%, 1 w	GB2231
R5	Resistor, deposited carbon 500 k, 1%, 2 w	DR620
R6	Resistor, deposited carbon 144 k, 1%, 1 w	DR67
R7	Resistor, precision wirewound 149 k, .5%, 1 w	PR611

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
R8, 12, 14, R105	Resistor, composition 1 m, 10%, 1/2 w	EB1051
R9, 10	Resistor, deposited carbon 300 k, 1%, 1 w	DR614
R13	Resistor, deposited carbon 250 k, 1%, 1 w	DR613
R15, 19	Resistor, precision wirewound 125 k, .1%, 1 w	PR610
R16	Resistor, precision wirewound 509Ω, .1%, 1/2 w	PR37
R17	Resistor, precision wirewound 320 k, .5%, 1 w	PR614
R18	Resistor, precision wirewound 158 k, .1%, 1 w	PR620
*R20 thru R25	Resistor, precision wirewound 40 k, .02%, 1/2 w, matched	PR512
*R26 thru R36	Resistor, precision wirewound 8 k, .05%, 1/2 w, matched	PR48
*R37 thru R47	Resistor, precision wirewound 1.6 k, .1%, 1/2 w, matched	PR46
*R48 thru R58	Resistor, precision wirewound 320Ω, .1%, 1/2 w, matched	PR39
*R59 thru R68	Resistor, precision wirewound 64Ω, .1%, 1/2 w, matched	PR24
R69	Resistor, composition 39 k, 10%, 1 w	GB3931
R101	Resistor, composition 100Ω, 10%, 1 w	GB1011

* Factory matched - Specify instrument serial number for each resistor when ordering. See page 9, paragraph 4, of manual for additional information.

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
R102	Resistor, composition 2.7 k, 10%, 1 w	GB2721
R103,104,111	Resistor, deposited carbon 8.2 k, 1%, 1/2 w	DR411
R106,109	Resistor, deposited carbon 980 k, 1%, 1/2 w	DR623
R107,108	Resistor, deposited carbon 9 m, 1%, 1 w	DR78
R110	Resistor, deposited carbon 20 k, 1%, 1/2 w	DR53
P1	Potentiometer, wirewound 1 k, 10%, 2 w	P1KA
P2	Potentiometer, wirewound 5Ω, 20%, 2 w	P5A
P3	Potentiometer, wirewound (Trimit) 10 k, 10%, 1/4 w, printed circuit type	P10KTA
P101,102	Potentiometer, wirewound 5 k, 10%, 2 w	P5KA
V1	Tube, high vacuum rectifier Type 5Y3-GT	5Y3-GT
V2	Tube, pentode Type 6AQ5A	6AQ5A
V3	Tube, pentode Type 6AU6	6AU6
V4,102	Tube, dual triode Type 12AU7	12AU7

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
V5	Tube, voltage regulator Type OA2	OA2
V6	Tube, dual triode Type 12AX7	12AX7
V7, V8	Tube, voltage reference Type OG3	OG3
V101	Tube, voltage regulator Type OB2	OB2
X101	Rectifier, selenium 117 v, 65 ma	RE1A
S1	Switch, rotary 2 pole, 5 postion, shorting	SR18
S2, S3, S4	Switch, rotary 2 pole, 10 position, shorting	SR19
S5	Switch, rotary 1 pole, 11 position, shorting	SR20
S6	Switch, rotary 6 pole, 5 position	SR17A
S7	Switch, rotary Momentary on	SR16
B1	Standard cell, unsaturated, low hysteresis	X223
F1	Fuse, cartridge 2 amperes	F2
M1	Meter, 50-0-50 microamp. with special scale	M12

CIRCUIT SYMBOL	DESCRIPTION	FLUKE STOCK NO.
T1	Transformer, power	T9
	Fuse holder, bayonet type	X12
	Binding post	X219
	Binding post insulator, black	X218
	Binding post insulator, red	X217
	Binding post spacer	X220
	Binding post shorting link	X221
	Knob, 2 inch, no pointer	X233
	Knob, 1 inch, pointer	X231
	Cable, power, 2 conductor, #18	X27E
	Bushing, line cord strain relief	X212
	Feet, rubber mounting	X224
	Handle, leather	X241
	Studs, handle mounting	X248
	Shaft, handle mounting	407-201-0
	Washer, flat insulated for potentiometer mounting	X93
	Washer, shoulder insulated for potentiometer mounting	X93A

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to their factory for that purpose, and to making good at their factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser to them with transportation charges prepaid, and which on their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of opertion repairs will be billed at cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information we will give you service data or shipping instructions.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

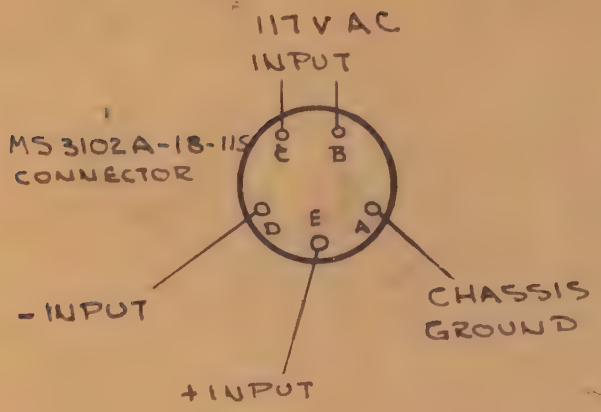
All shipments of JOHN FLUKE MFG. CO., INC. instruments should be made via Railway Express prepaid. The instrument should be shipped in original packing carton, or if not available any suitable container that is rigid. If substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

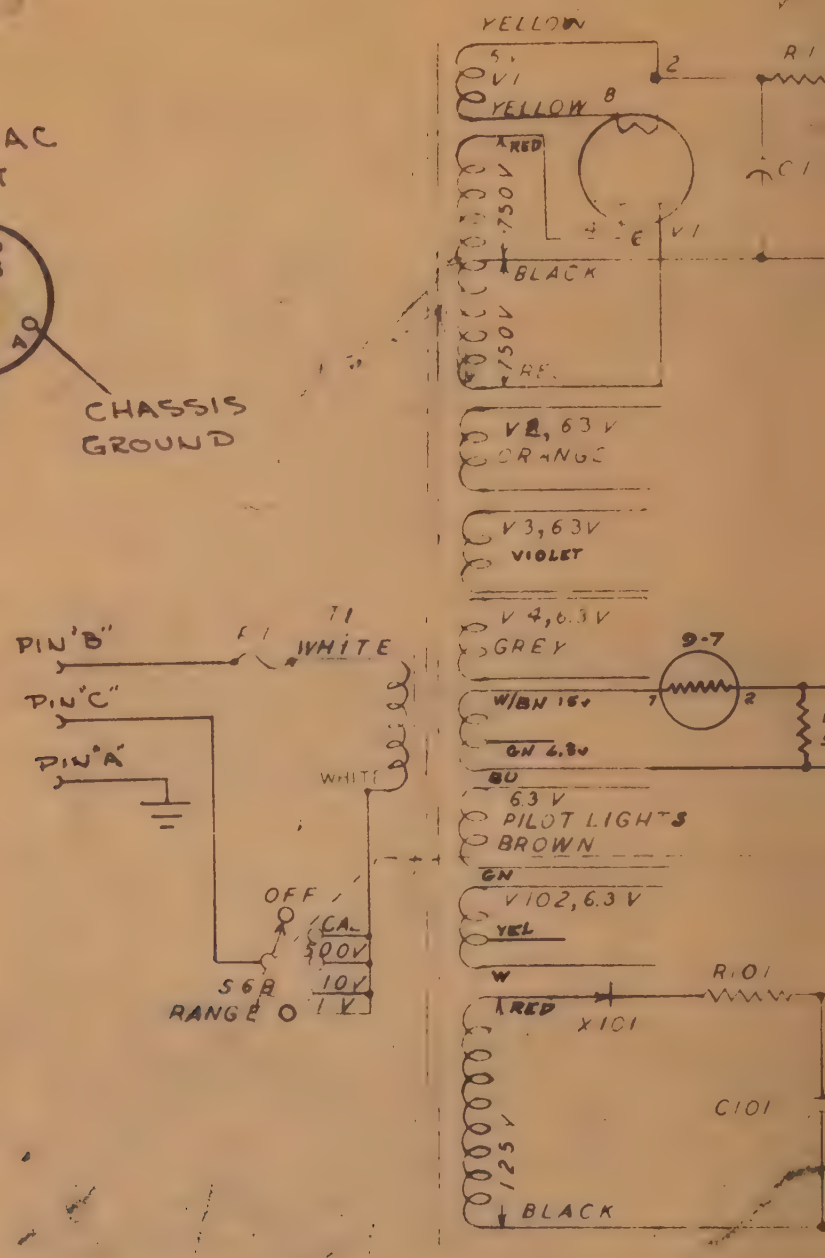
CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt of same. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include Model number, type number, and serial number when referring to this instrument for any reason.

Do not hesitate to contact us concerning any questions which you may have about this instrument. The JOHN FLUKE MFG. CO., INC. will be happy to answer all application questions which will enhance your use of this instrument.

JOHN FLUKE MFG. CO., INC., P. O. BOX 7161, SEATTLE 33, WASHINGTON

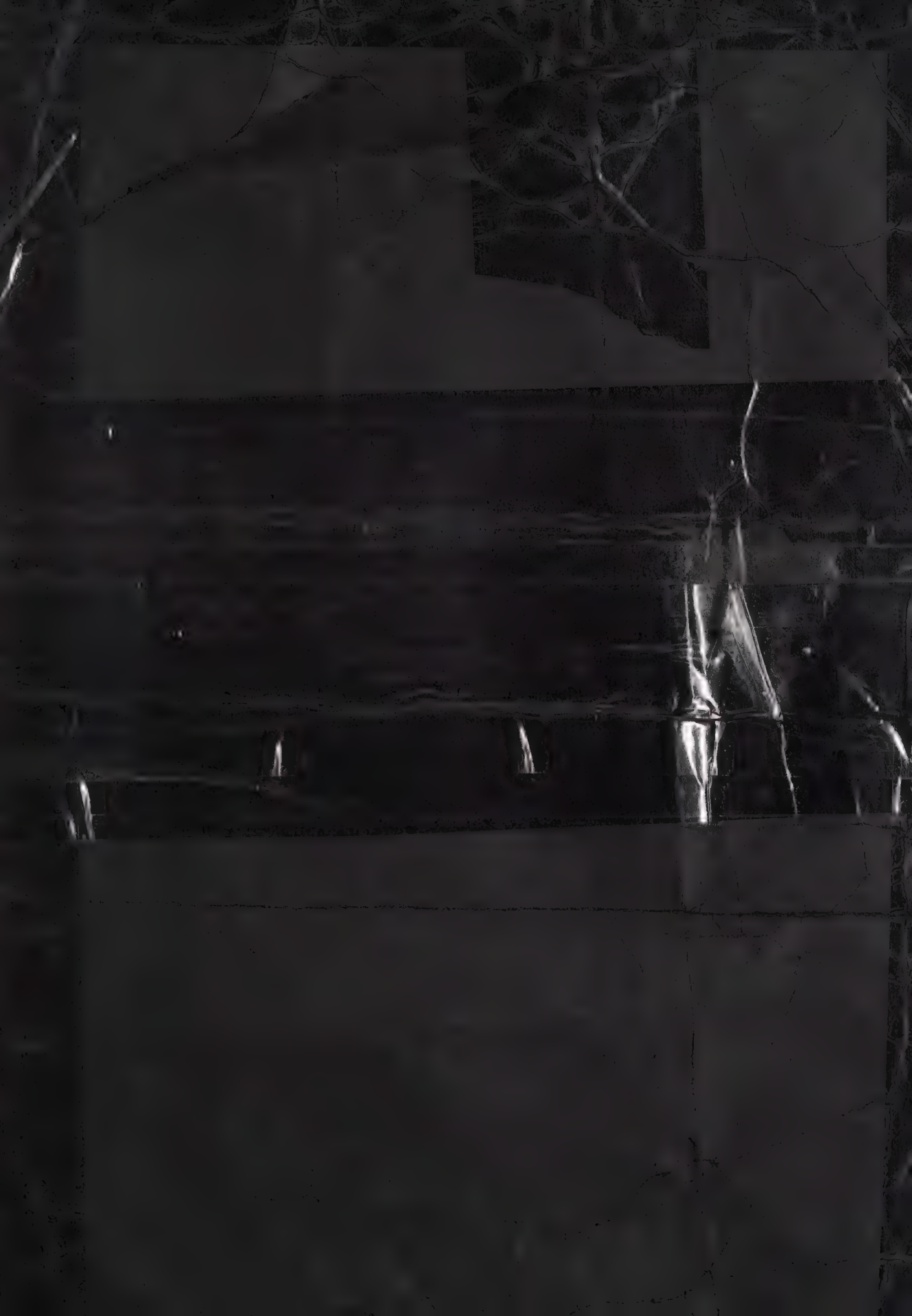


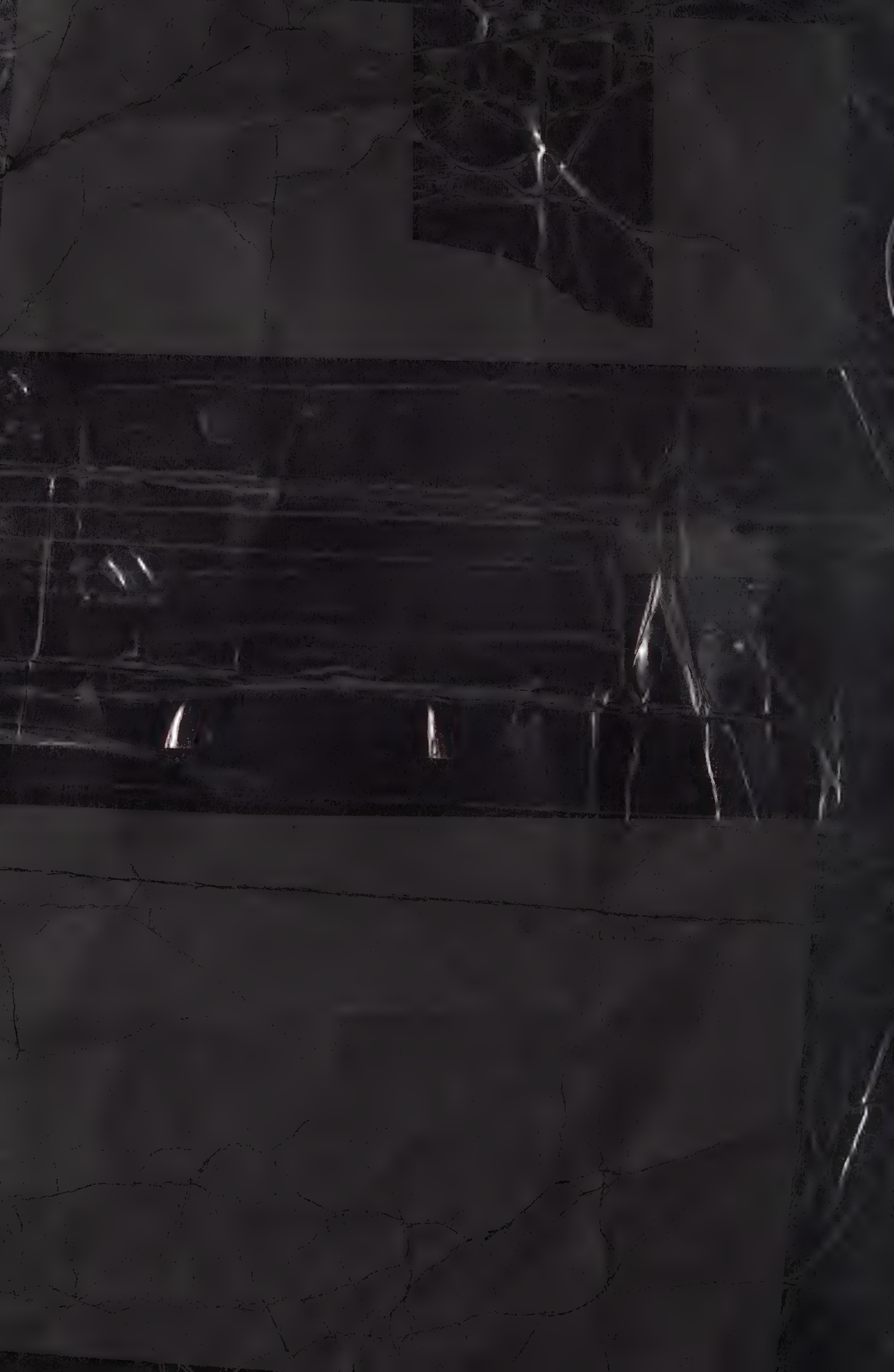


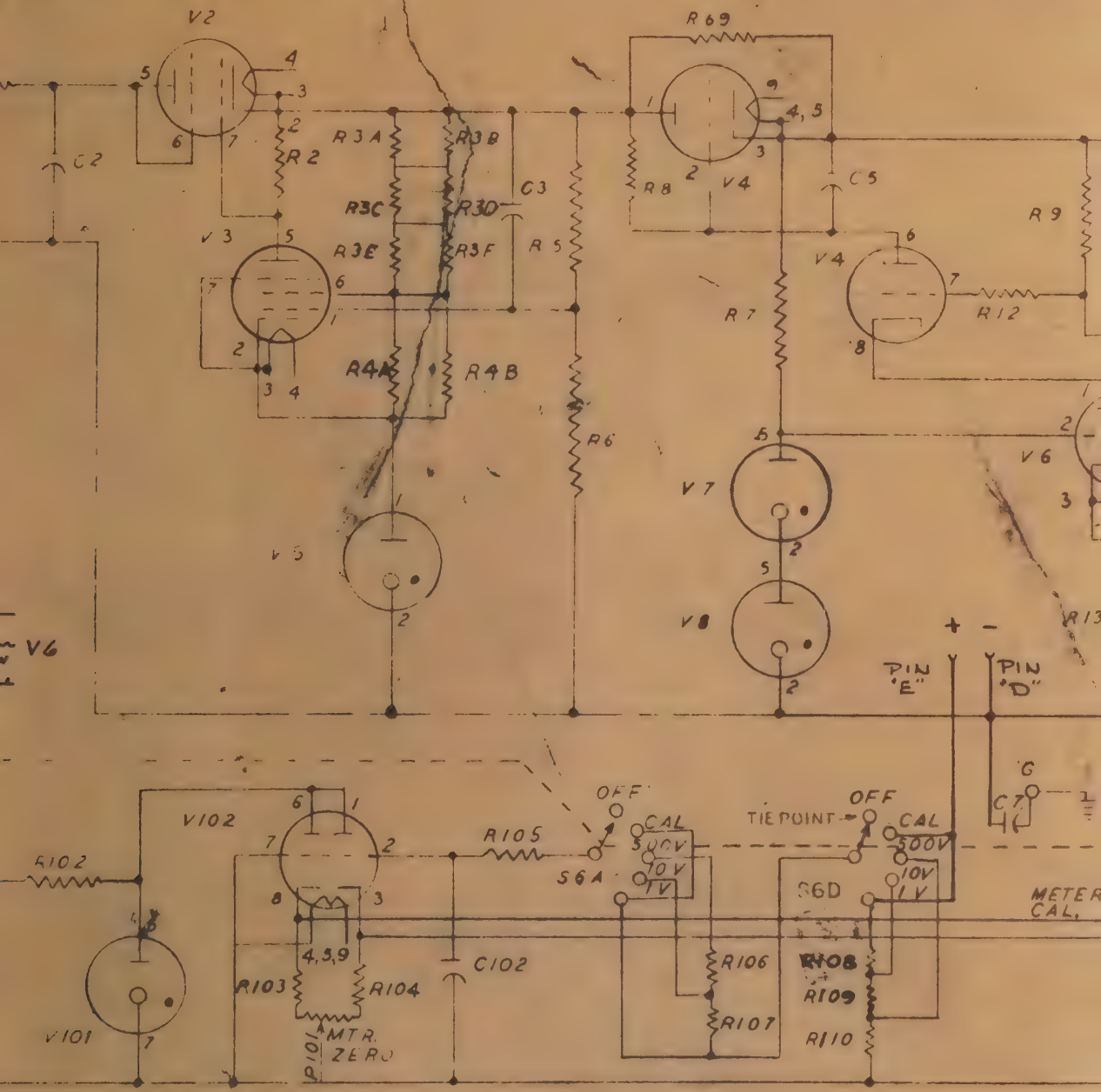
V1 - 5V3 - GT
V2 - 6AQ5A
V3 - 6AL5
V4 - 12AU7
V5 - 0A2
V6 - 12AY7
V7 - OG3
V8 - OG3
V101 - OB2
V102 - 12AU7
X101 - 65 MA
SELENIUM RECTIFIER

C1 - 1 MFD - 1000
C2 - 1 MFD - 1000
C3 - 0.1 MFD - 600
C5 - .047 MFD - 400
C6 - .01 MFD - 160
C7 - 0.1 MFD - 600

C101 - 8 MFD - 250
C102 - .022 MFD -
M1 - 50 - 0 - 50 μA
F1 - 2 AMP FUSE

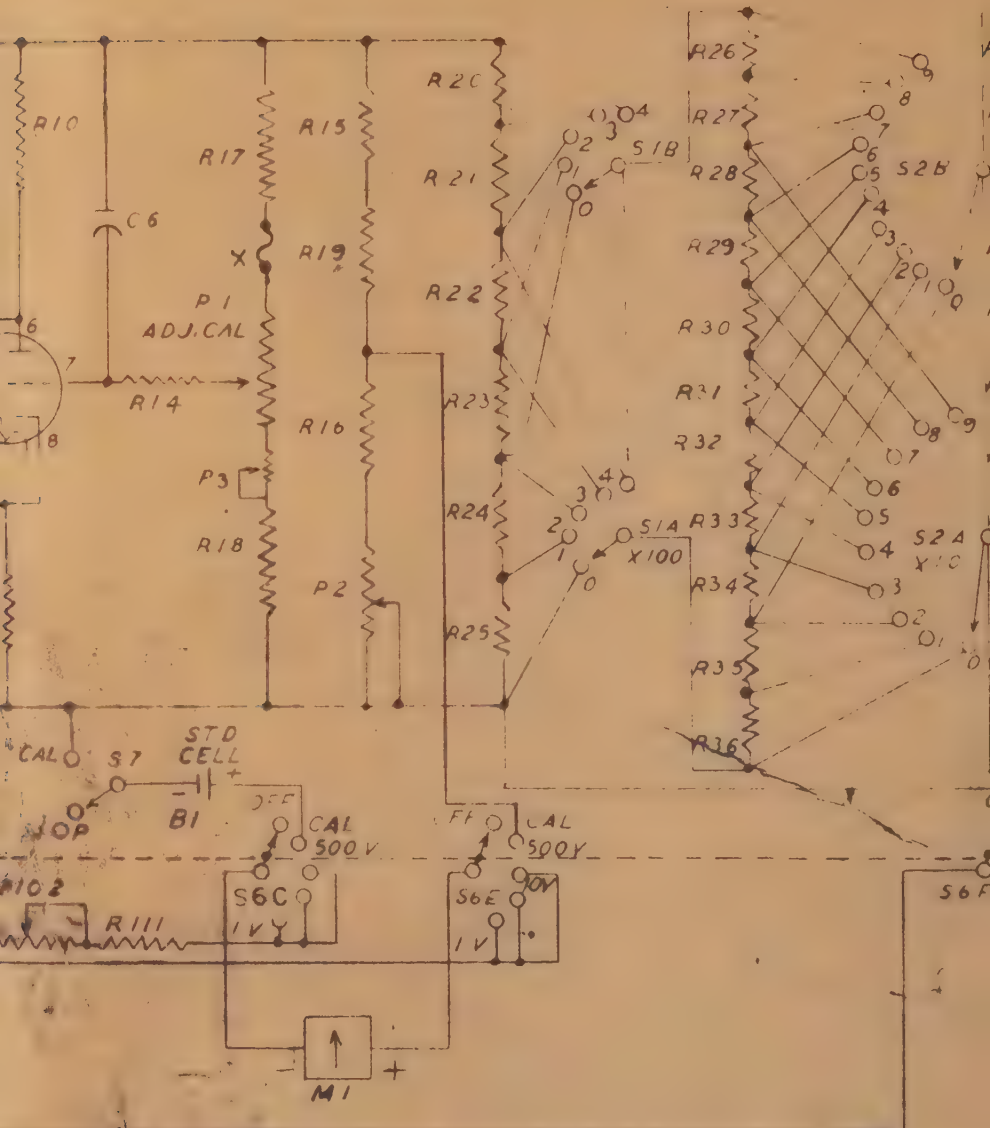




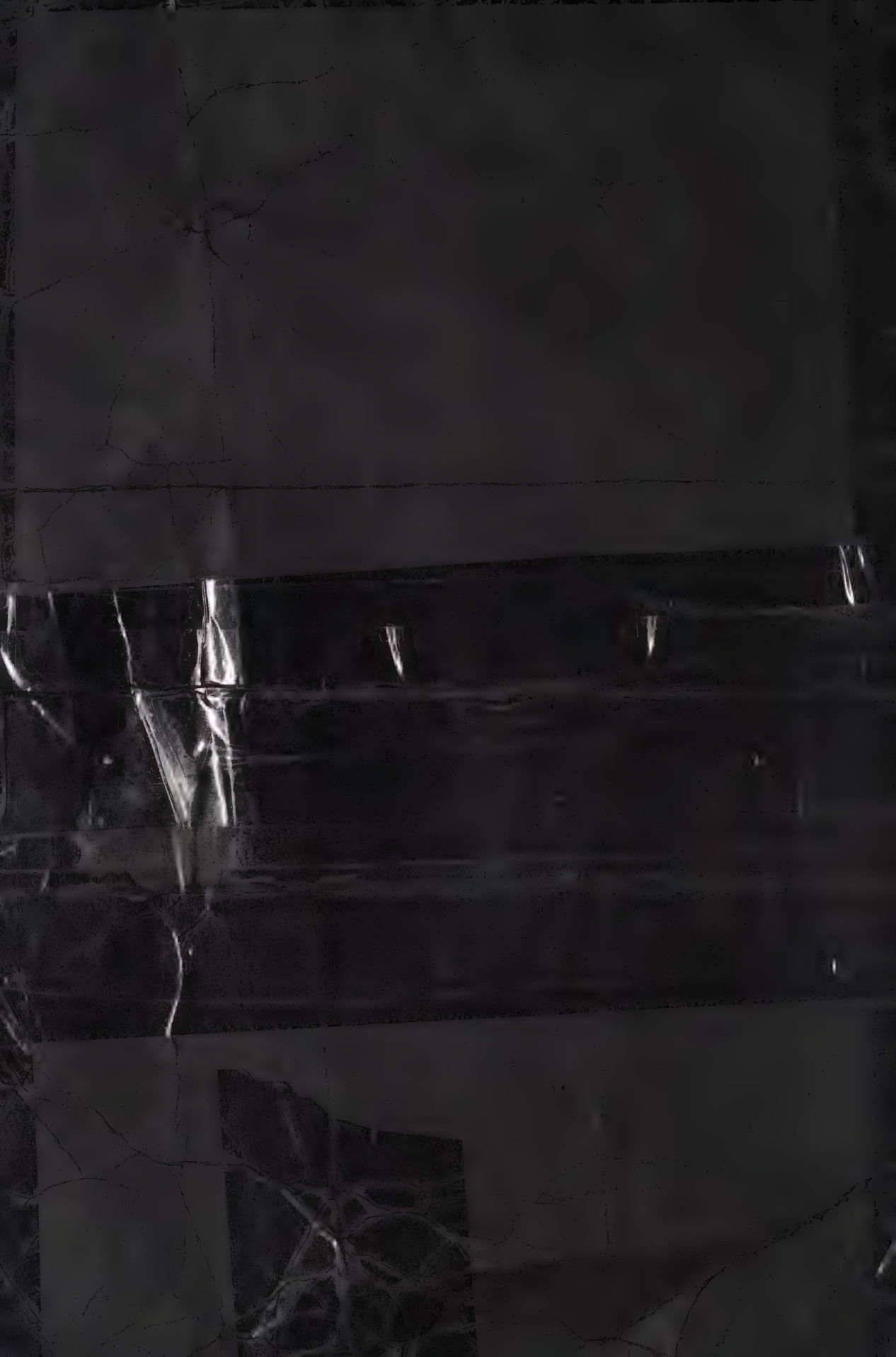


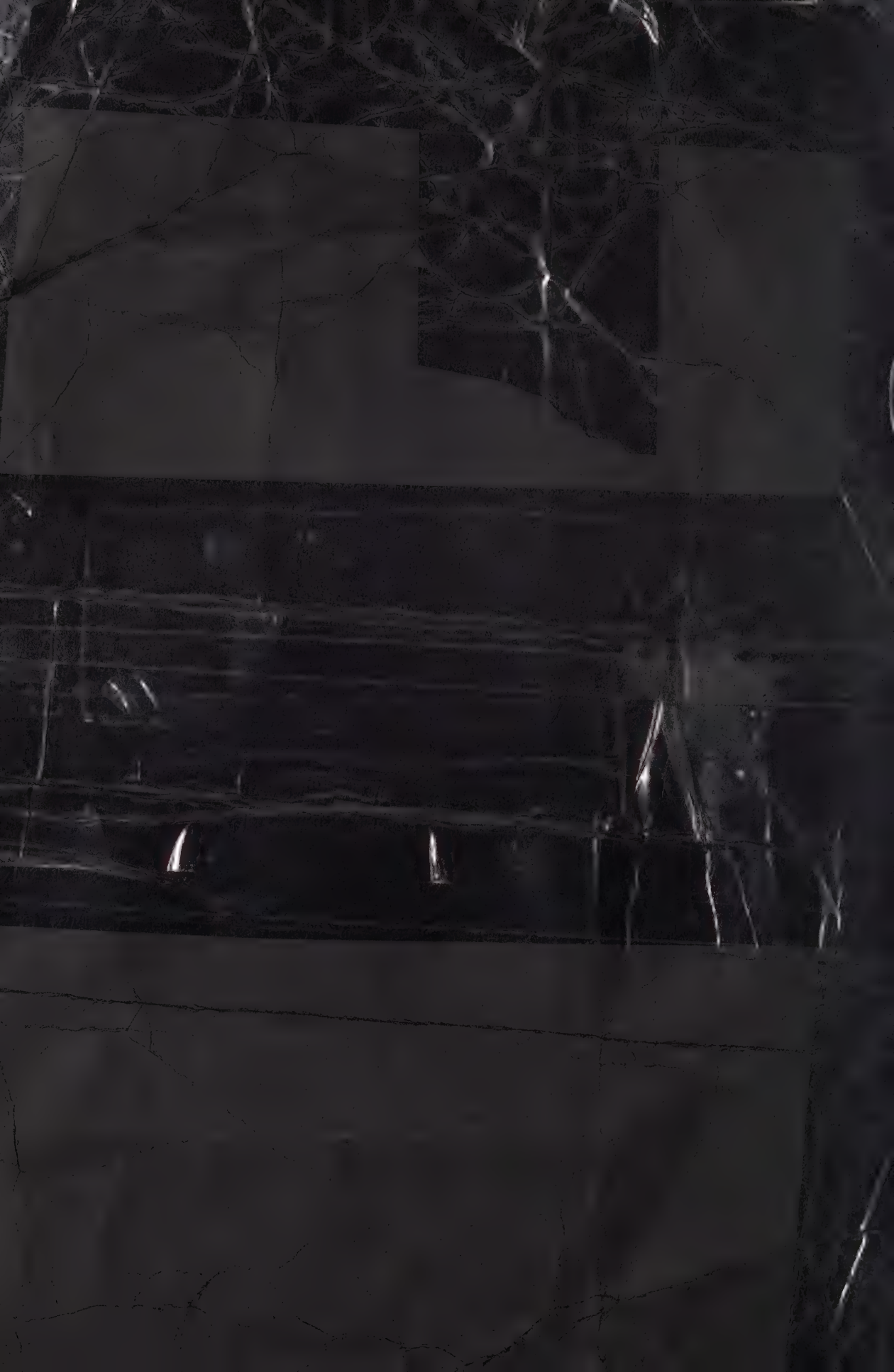
R1 - 390 Ω - 1 W - CARBON - 10 %
R2 - 470 K - 1/2 W - CARBON - 10 %
R3 A-F - 22 K - 1 W - CARBON - 10 %
R4 A-B - 22 K - 1 W - CARBON - 10 %
R5 - 500 K - 2 W - DEPOSITED CARBON - 1 %
R6 - 144 K - 1 W - DEPOSITED CARBON - 1 %
R7 - 149 K - 1 W - WW 0.5 %
R8 - 1 MEG - 1/2 W - CARBON - 10 %
R9 - 300 K - 1 W - DEPOSITED CARBON - 1 %
R10 - 300 K - 1 W - DEPOSITED CARBON - 1 %
R12 - 1 MEG - 1/2 W - CARBON 10 %
R13 - 250 K - 1 W - DEPOSITED CARBON - 1 %

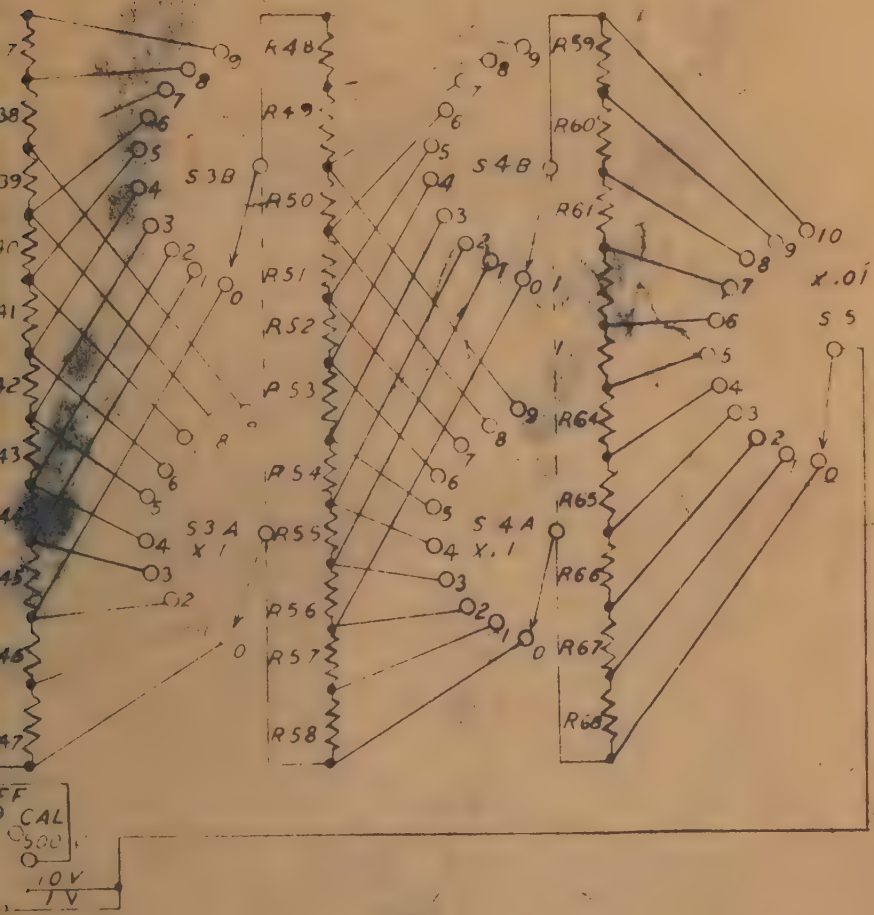
R14 - 1 MEG - 1/2 W - C
R15 - 125 K - 1 W - WW
R16 - 309 Ω - 1/2 W - W
R17 - 320 K - 1 W - WW
R18 - 150 K - 1 W - WW
R19 - 125 K - 1 W - WW
R20 - 25 - 40 K - 1 W - W
R26 - 36 - 8 K - 1/2 W - W
R37 - 47 - 1.6 K - 1/4 W - W
R48 - 98 - 320 Ω - 1/2 W
R39 - 68 - 64 Ω - 1/2 W
R101 - 100 Ω - 1 W - CAR



R102 - 2.7 K - 1 W - CARBON - 10 %
R103 - 8.2 K 1/2 W - DEPOSITED CARBON - 1 %
R104 - 82 K 1/2 W - " " " "
R105 - 1 MEG - 1/2 W - CARBON - 10 %
R106 - 980 K - 1/2 W - DEPOSITED CAR - 1 %
R107 - 9 MEG - 1 W " " " "
R108 - 9 MEG - 1 W " " " "
R109 - 980 K - 1/2 W - " " " "
R110 - 20K - 1 2 W - " " " "
R111 - 8.2 K - 1/2 W - " " " "
R [illegible] - 33 K - 1 W - CARBON - 10 %
T1 - POWER TRANSFORMER (SPECIAL)
X - JUMPER ALLOWS FOR ADDITION OF COMPENSATING RESISTOR AS OUTLINED IN INSTRUCTION BOOK



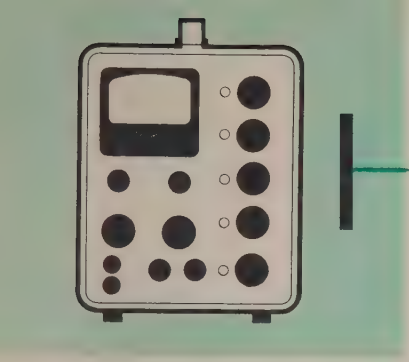




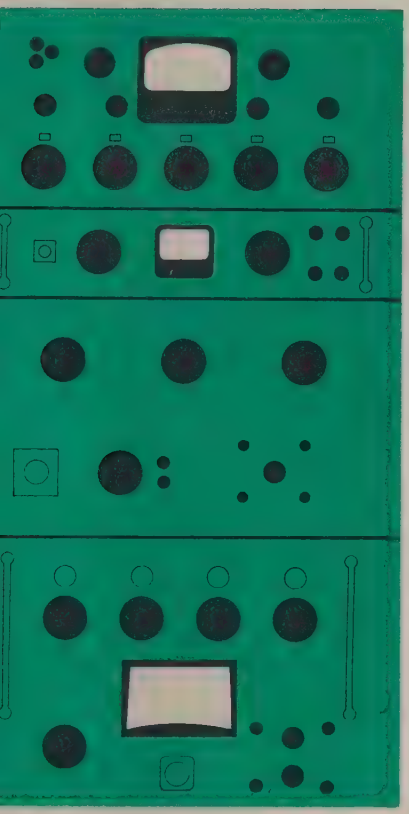
W-POT
OSTAT
OSTAT
W-WW POT
W-WW POT

SER 125 & ABOVE

CIRCUIT DIAGRAM OF DIFFERENTIAL VOLTMETER		
MODEL 800R/C		DWG. 800R/C-101
DATE 4/6/60	DRAWN BY V.L.H.	CHECKED BY
JOHN FLUKE MFG. CO. INC. SEATTLE-WASH		



JOHN FLUKE



- **IMPEDANCE BRIDGE**
- **PRECISION DC-AC DIFFERENTIAL VOLTMETERS**
- **POWER SUPPLIES**
  - GENERAL PURPOSE
  - PRECISION CALIBRATED
  - CONSTANT CURRENT
  - HIGH VOLTAGE
- **VAW METER**

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7161 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

All prices quoted, F.O.B., factory, Seattle

WE PROUDLY PRESENT THE NEW WIDE RANGE IMPEDANCE BRIDGE

Featuring

CONVENIENCE—Direct reading controls, simple to operate and always positioned at the proper angle.

SMALL SIZE—Only 6x7x9-inch cabinet size. Weight 10 pounds.

WIDE RANGE—Resistance 0-12 megohms
Capacitance 0-1200 microfarads
Inductance 0-1200 henrys

PRECISION—Incorporating the best materials, standards, and workmanship, the Model 710A measures resistance to 0.1%, capacitance to 0.2% and inductance to 0.3%.

PRICE $525.00

PRECISION

DIFFERENTIAL VOLTMETERS

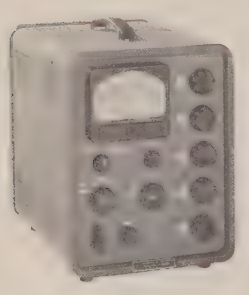
PRECISION DC DIFFERENTIAL VOLTMETERS

MODEL **801**

The jf Models 801 and 801H Precision DC Differential Pontentiometric Vo meters are sensitive, high resolution instruments permitting rapid measurement DC Voltage. Accuracy is 0.05% of any input voltage over the range of 0.1 to 5 volts. Extreme accuracy and stability are achieved by advanced circuit desi which incorporates a chopper stabilized null amplifier and a standard cell ref ence. Available in either cabinet or rack mounting configurations.

801 SPECIFICATIONS

MODEL **801**	VOLTAGE RANGES:	0.5, 5, 50, and 500V DC
	ACCURACY:	±0.05% from 0.1 to 500V ±0.1% or 50uv, whichever is greater, below 0.1V
	NULL SENSITIVITY RANGES:	10V, 1V, 0.1V, and 0.01V
	MAX. METER RESOLUTION:	50uv
	INPUT IMPEDANCE:	Infinite at null
	DIMENSIONS:	Cabinet—9¾" W x 13½" H x 14" D Rack—19" W x 8¾" H x 13¼" D
	WEIGHT:	Cabinet—25 lbs., Rack—28 lbs.
	PRICE:	Cabinet—$485.00, Rack—$505.00
MODEL **801H**	801H SPECIFICATIONS ARE THE SAME AS FOR THE 801 EXCEPT:	
	NULL SENSITIVITY RANGES:	10V, 1V, 0.1V, 0.01V, and 0.001V
	MAX. METER RESOLUTION:	5uv
	PRICE:	Cabinet—$555.00, Rack—$575.00



MODEL **801H**

PRECISION DC-AC DIFFERENTIAL VOLTMETERS

The jf Model 803 DC-AC Differential Voltmeter is a compact, portable voltmet designed for precise measurement of DC or AC voltages. Ease of operation a inherent protection from accidental overload, combined with an accuracy of 0.2 for AC voltages and 0.05% for DC voltages, make this a truly versatile instr ment. The Model 803 may be used as a vacuum tube voltmeter, as a differenti DC voltmeter, or as a differential AC voltmeter. This model is available in eith cabinet or rack mounting.

803 SPECIFICATIONS

MODEL **803**	VOLTAGE RANGES:	AC—5, 50, and 500V DC—0.5, 5, 50, and 500V
	ACCURACY:	AC— ±0.2% from 0.5 to 500 VAC, 30 CPS to 5 KC DC— ±0.05% from 0.1 to 500VDC ±0.1% or 50uv, whichever is greater, below 0.1V
	NULL SENSITIVITY RANGES:	AC—100V, 10V, 1V, 0.1V and 0.01V DC—10V, 1V, 0.1V, and 0.01V
	MAX. METER RESOLUTION:	50uv
	INPUT IMPEDANCE:	AC—1 Megohm, 25 uufd DC—Infinite at null
	DIMENSIONS:	Cabinet—9¾" W x 13½" H x 16⅝" D Rack—19" W x 8¾" H x 17-5/16" D
	WEIGHT:	Cabinet—30 lbs., Rack—33 lbs.
	PRICE:	Cabinet—$875.00, Rack—$895.00

MODEL **803**

ACCESSORIES—MODEL 80A VOLT BOXES

MODEL **80A**

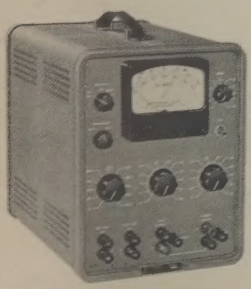
The jf 800 series differential voltmeters may be used to measure DC voltag in excess of 500 volts by utilizing an appropriate voltage divider (Volt Box). T division ratio of all models is accurate to 0.01% and long term stability is bet than 0.01% per year. The approximate magnitude and the polarity of the unkno high voltage may be easily observed with the newly incorporated center ze panel meter.

Model No.	Division Ratio	Maximum Input	Total Resistance	Price
80A-1	2:1	1 KV	1 Megohm	$ 60.00
80A-2	4:1	2 KV	2 Megohms	$ 70.00
80A-3	6:1	3 KV	3 Megohms	$ 80.00
80A-4	8:1	4 KV	4 Megohms	$ 90.00
80A-5	10:1	5 KV	5 Megohms	$100.00
80A-6	2:1	1 KV	10 Megohms	$120.00

jf PRECISION

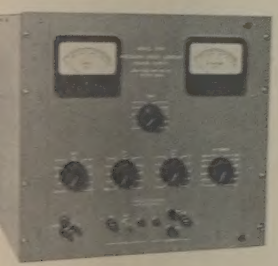
POWER SUPPLIES

ODEL 406 0-530V 0-100 ma

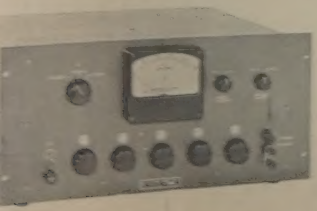


DEL 407 0-555V 0-300 ma

DEL 301E 1.02-512V 0-300 ma



DEL 301C 1.02-1012V 0-400 ma



DEL 351A 1ua-100 ma 0-100V

John Fluke power supplies have achieved a position of universal acceptance in the fields of production testing, general laboratory development, and nuclear research. The complete line of jf laboratory and nuclear supplies range in output from 0 to 10 kilovolts and 0 to 400 milliamperes. These units have regulation and stability in order of 0.005%.

Continued development of new concepts and an acute awareness of the needs of the engineer have established jf as a pioneer in instrument development. Use of highest quality components, conservative design practice, skilled craftsmanship, and stringent quality control have led to jf supplies being recognized as the standard of the industry.

GENERAL PURPOSE—DC LABORATORY POWER SUPPLIES:

Ideal for circuit development, production checkout, meter calibration, and general laboratory applications.

MODEL	VOLTAGE	CURRENT	REGULATION LINE	REGULATION LOAD	STABILITY PER HOUR	MAX. RIPPLE RMS	RESOLUTION	PRICE
406	0-530V	0-100 ma	0.01%	0.01%	0.01%	1mv	2mv	CAB. $285.00 RACK $305.00
407	0-555V	0-300 ma	0.01%	0.01%	0.01%	1mv	2mv	CAB. $335.00 RACK $355.00
PRECISION CALIBRATORS								
301E	1.02-512V	0-300 ma	0.005%	0.005%	0.005%	2mv	50uv	$695.00
301C	1.02-1012V	0-400 ma	0.005%	0.005%	0.005%	2mv	50uv	$985.00

CONSTANT CURRENT POWER SUPPLY:

Applicable to all constant current applications—an excellent calibration and test instrument, an invaluable aid in magnetic circuit development.

MODEL	VOLTAGE	CURRENT	REGULATION LINE	REGULATION LOAD	STABILITY PER HOUR	MAX. RIPPLE RMS	RESOLUTION	PRICE
351A	0-100V	1ua-100 ma	0.01%	0.01%	0.005%	0.05% plus 0.5ua	1ua	$845.00

THE INSTRUMENTS SHOWN in this catalog were selected upon their performance and wide range of applications.

VOLTMETER, POWER SUPPLY or VAW METER—each unit, before shipment, receives through a series of rigid test procedures, a thorough and specialized check-out. This assures a product capable of reliable performance over a long period of time.

DEDICATED to the end that our instruments keep pace with the industry's growing needs, we solicit your inquiries and comments.

JOHN FLUKE MANUFACTURING CO., INC.

P. O. Box 7161 • Seattle 33, Washington

PHONE PRospect 6-1171 — TWX — Halls Lake TLX 852

The right is reserved, without notice, to make such changes in equipment, design, or components as engineering or manufacturing process may warrant.

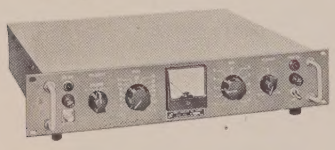
Prices subject to change without notice.

jf PRECISION

POWER SUPPLIES

MODEL 409A 170-1530V 0-3 ma

MODEL 402M 500-1600V 0-1 ma



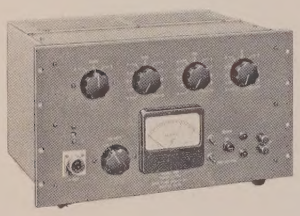
MODEL 412A 500-2010V 0-15 ma

HIGH VOLTAGE SUPPLIES:

Designed to power photomultiplier tubes and ionization chambers . . . for researc and development of traveling wave tubes and backward wave oscillators. . . .

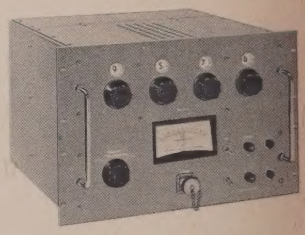
MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY PER HOUR	MAX. RIPPLE RMS	RESOLUTION	PRICE
			LINE	LOAD				
409A	170-1530V	0-3 ma	0.01%	0.4%	0.02% (Per Day)	0.002%	85V steps	$335.00
402M	500-1600V	0-1 ma	0.03%	0.03%	0.01%	5mv	100mv	$320.00
412A	500-2010V	0-15 ma	0.01%	0.01%	0.005%	5mv	10mv	$455.00
405	600-3100V	0-15 ma	0.01%	0.005%	0.005%	5mv	10mv	$595.00
408A	500-6010V	0-20 ma	0.01%	0.01%	0.005%	5mv	10mv	$695.00
410A	1000-10,010V	0-10 ma	0.01%	0.01%	0.005%	5mv	10mv	$1095.0

Watch for this company's regular advertising in ELECTRONIC DESIGN for latest in production develop



MODEL 405 600-3100V 0-15 ma

MODEL 408A 500-6010V 0-20 ma



MODEL 410A 1-10.01KV 0-10 ma

VAW METER — *for measuring* VOLTS, AMPERES, WATTS

The jf Model 102 VAW Meter has a maximum true power sensitivity of 225 microwatts and will measure up to 18 kilowatts over the frequency range of 20 CPS to 100 KC. With a one megohm input resistance and a shunt drop of only 45 millivolts full scale, the Model 102 generally produces negligible insertion loss effects on the circuit under test. The VAW Meter is ideally suited to measuring true power consumed by a wide variety of loads including both linear and non-linear elements such as servo components, transformers, rectifiers, and substantially any power consuming circuit configuration.

Model 102—Price $555.00

VOLTAGE (full scale)	CURRENT (full scale)	POWER	POWER FACTOR RANGE	FREQUENCY RESPONSE	ACCURACY	INPUT IMPEDANCE
1.5-600V	1.5ma-30A	225uw to 18KW	1.0 0.1 0.1	20CPS—100KC 20CPS—20KC 20KC—40KC	3% 3% 5%	1 Megohm 25uufd

JOHN FLUKE MFG. CO., INC.
P. O. BOX 7161 SEATTLE 33, WASH.

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